

Master Thesis: Interactive 3D Exploration of Large Video Datasets



University of
Zurich^{UZH}



Introduction

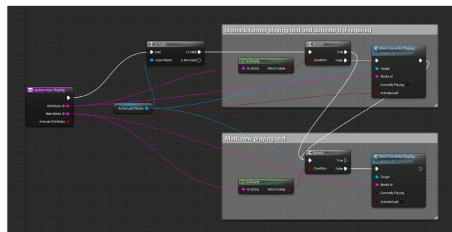
As the volume of humanity's video data continues to grow rapidly, there is an increasing need for systems that can support intuitive, efficient, and scalable exploration of large video datasets. Traditional data exploration tools, such as flat UIs or timeline-based interfaces, often fail to convey the complex relationships engagedly. To address this, we are developing a novel 3D game engine-based visualization system designed specifically to enhance the way users explore and interact with large-scale video datasets.

The core idea behind the current system is the use of a tree structure to model the dataset in a spatial and interactive 3D environment. In this model, the entire dataset is represented by the root node, and different branches correspond to various semantic feature categories. Users can navigate the tree structure visually, allowing them to gain an immediate, high-level understanding of how the dataset is organized and what content it contains. This visual metaphor bridges the gap between raw data and human cognitive processes by leveraging spatial organization and game-like interaction paradigms.

While the existing system offers a compelling visual foundation, it is currently limited in its interactivity and data retrieval capabilities. Users can only browse what is statically loaded into the system, and there is no dynamic mechanism for filtering, searching, or querying based on user input or interest. Furthermore, the current interaction model is not yet aligned with standard practices in modern game engines, which can hinder extensibility and performance. In this project, we

aim to address these limitations and add new functionalities such as dynamic data loading, filtering, searching, and querying based on user input or interest, as well as a recommendation system to help users find relevant data points.

The system is built using Unreal Engine 5 and the C++ programming language. In UE5, the system is implemented using Blueprint Visual Scripting, which is a visual programming language that allows for the creation of complex logic and gameplay mechanics without traditional C++ code.



Blueprint Visual Scripting system in Unreal Engine 5

Assignment

The following tasks will be part of the project:

- **Database Integration:** By connecting the 3D engine to a flexible and scalable backend database, we aim to enable real-time querying, dynamic data loading, and personalized exploration pathways. This will allow users to search for specific content and have the results visualized instantly within the 3D interface.
- **Recommendation System:** We aim

to develop a recommendation system that suggests relevant data points based on nearest-neighbor computations in the space of dimensionality-reduced data.

- **Enhanced User Experience and Interactivity:** Beyond technical integration, we are also focused on improving the overall usability, accessibility, and engagement of the system. This includes adding new visual components and views to provide deeper insights, refining interaction models to support smoother navigation and data manipulation.
- **User Testing and Evaluation:** Design and conduct user studies to evaluate the effectiveness, usability, and performance of the enhanced system.

Project Type

Master Thesis

Requirements

Experience in programming with 3D or game engines.

Supervision

Prof. Dr. Renato Pajarola
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Workload

- 10% Theory
- 70% Implementation
- 20% Testing and evaluation

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